



2015 Louise Brearley Messer ANZSPD Post-graduate Essay Competition

Discuss tooth coloured crowns in the primary dentition: developments, improvements and limitations

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Abstract

Objectives: This study aims to provide (i) a narrative review of the development, improvement and limitations of the various tooth coloured crowns (polycarbonate crowns, open faced stainless steel crowns, pre-veneered stainless steel crowns, composite resin strip crowns, laboratory fabricated composite resin crowns, copolyester crowns, epoxy paint crowns, artglass crowns and zirconia crowns) and discuss their limitations, and (ii) an evidence-based assessment of the tooth coloured crowns in the primary dentition. **Methods:** A comprehensive literature search of studies that employed tooth coloured crowns for primary teeth, catalogued in MEDLINE was performed using the keywords; “tooth, deciduous, crowns, aesthetics”. Only human studies were included, and papers not published in the English language, abstracts, retrospective studies, and case reports were excluded. **Results:** Of the 67 citations indexed in MEDLINE only three clinical studies were included for the final assessment; of which, one was a randomized control trial, and the remaining two were prospective cohort studies. **Conclusion:** Although tooth coloured crowns are currently used in the primary dentition, there is a no scientific evidence to support the superiority of one tooth coloured crown over the others.

Introduction

Dental caries, which is considered to be the most common chronic disease in childhood, is estimated by the World Health Organisation to be a major health

problem that affects 60% to 90% of the children in the industrialized countries¹. In Australia, the proportion of 5-year old children utilizing dental services have, on average, 2.32 decayed, missing or filled teeth². Early childhood caries (ECC) in the primary dentition follows a specific pattern with the maxillary central and lateral incisors being the most commonly affected teeth followed by the molars, canines, and then the mandibular central and lateral incisors, respectively. The individual's caries risk, extent of the carious lesions, parental attitude and motivation towards treatment, plus the child's age and co-operation are critical to the choice of the appropriate restorative options³. Nevertheless, restorative management of ECC is only the first phase of treatment because ultimate success depends upon maintaining a favourable oral environment.

Children should not be considered to be small adults because their anatomy is different and they behave differently. Anxiety and fear act as barriers preventing the delivery of dental care as they lead to non-attendance, failed appointments, poor co-operation and even disruptive behaviour in the dental environment. Nonetheless, it has been demonstrated that parents place a similar emphasis on their child's dental appearance as they do on their child's general health^{4,5}. One study⁴ reported that parents believed that having two missing maxillary primary incisors was less attractive than having only one missing incisor. The majority of the parents in this study also preferred conservative treatment for teeth with a sinus tract and preferred active

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by Sue Cartwright,
BDS, Dip Clin Dent, M Ed

I would like to bring your attention to 3 items:

An excellent webinar titled *“Diagnosing and Managing Dental Caries and Erosion in Children and Adolescents”* that was delivered by Prof. Bernadette Drummond via the Colgate Oral Health Network in July this year.

This webinar can now be accessed on demand at

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treatment over no-treatment for discoloured teeth⁴. Furthermore, Holan et al.⁵ reported that approximately 87% of the parents opted for dental treatment to restore the primary tooth even if the chance of success was only 50%. Young children do have feelings about their appearance and this must be considered when deciding upon the choice of restorations for primary teeth⁶.

Full coronal restoration for primary teeth are indicated when there are; (i) carious lesions on multiple surfaces, (ii) evidence of developmental defects of enamel and dentine, (iii) extensive cervical decalcification, (iv) indications for pulp therapy, (v) multiple inter-proximal lesions associated with poor oral hygiene (high-risk patients), and (vi) children with disruptive behaviours which would make placing intra-coronal restorations difficult⁷.

This essay aims to; (i) provide a narrative review on the development, improvements and limitations of the various tooth coloured crowns used in the primary dentition, and (ii) review the literature to identify scientific evidence to support the superiority of the various tooth coloured crowns used in the primary dentition. The narrative review will be presented under the following headings: (i) crowns for anterior teeth and (ii) crowns for posterior teeth. This will be followed by a general discussion on the superiority of the various types of crowns. Furthermore, to facilitate easy reference and direct comparisons the advantages and disadvantages are tabulated in Tables 1 and 2 (page 6).

Methodology:

In September 2015, a comprehensive literature search of studies, that employed tooth coloured crowns for primary teeth, catalogued in MEDLINE was performed using the keywords; "tooth, deciduous, crowns, aesthetics" ["tooth, deciduous"[MeSH Terms] OR ("tooth" [All Fields] AND "deciduous" [All Fields]) OR "deciduous tooth" [All Fields] OR ("tooth" [All Fields] AND "deciduous" [All Fields]) OR "tooth, deciduous" [All Fields] AND ("crowns" [MeSH Terms] OR "crowns" [All Fields] AND ("aesthetics" [MeSH Terms] OR "aesthetics" [All Fields]). Only human studies were included, and papers not published in the English language, abstracts, retrospective studies, and case reports were excluded.

Literature search:

Of the 67 citations indexed in MEDLINE, three clinical studies⁸⁻¹⁰ were included for the assessment; of these only one was a randomized control trial (RCT)⁸, while

the remaining two were prospective cohort studies^{9,10}.

Crowns for anterior teeth

Polycarbonate crowns

Polycarbonate crowns were first described as a method for treating heavily broken down maxillary anterior teeth, by Stewart et al., in 1974¹¹. These crowns that have been used as temporary crowns on permanent teeth are made of a heat moulded acrylic resin. As polycarbonate crowns do not resist strong abrasive forces they are at risk of fracture or dislodgement. Contra-indications for the use of polycarbonate crowns include insufficient remaining sound tooth structure, deep over-bite, bruxism and crowding¹¹.

Open faced stainless steel crowns

Stainless steel crowns (SSC) are not ideal for restoration of primary incisors due to the poor aesthetic outcome. The open-faced SSC with a resin window, was described in 1983¹², to overcome the aesthetic challenges associated with a traditional SSC. A facial window is cut in the SSC and composite resin is then bonded into the space to replace the missing tooth structure^{12,13}.

This technique is time consuming and moisture control can be difficult. A sub-optimal aesthetic outcome is achieved as a result of the metal showing around the resin in the cervical, incisal and interproximal regions. Also the bond strength of the composite resin to the metal surface is weak. Hence, this method is unpopular¹⁴.

Pre-veneered stainless steel crowns

In order to overcome the problems associated with the open-faced SSC, pre-veneered crowns coated with a thermoplastic mesh were developed. When incisal forces are directed onto these veneers, failure occurs in two adhesive interfaces, either at the spot welds or at the mesh/plastic interface¹⁴.

Roberts et al.¹⁴, assessed 38 resin-faced SSC for an average period of 20.7 months and found that while parental satisfaction with the crowns was excellent, the high failure rate of the resin facings was an issue¹⁵. Similarly, other studies have demonstrated the risk of partial loss of the veneer to be around 8% to 12% and that the risk of complete veneer loss to be up to 24%¹⁶⁻¹⁹.

Composite resin strip crowns

The use of composite resin strip crowns for carious primary anterior teeth, as described by Webber et al.²⁰, provides an adequate aesthetic outcome. This technique involves

the use of a celluloid crown former which is used as a mould for the placement and shaping of the composite resin crown. The celluloid crown former is then "stripped off" to expose the underlying composite resin²¹⁻²³. Webber et al.²⁰, recommended the use of rubber dam for moisture control when placing composite resin strip crown.

Composite resin strip crowns are contraindicated in cases where the primary teeth are so severely broken down that they present with insufficient tooth structure for retention and bonding, deep over-bites, and in children with periodontal disease²⁰. Adequate tooth structure is critical to ensure successful bonding and the longevity of the restoration²⁴.

In 2001, Kupietzky²³ recommended floss ligatures to ensure sufficient moisture control and retract the gingival tissue and expose more enamel for composite resin bonding. Subsequently, he demonstrated an 88% retention rate for 112 composite resin strip crown restorations over a period of 4.5 years²⁵. Although the overall retention rates are reported to be around 80% over 24 to 36 months^{22,26}, one should be aware of the fact that greater the loss of tooth structure the higher the likelihood of failure of the composite resin strip crown²⁶.

Laboratory fabricated composite resin crowns

Incomplete polymerization of the composite resin material may occur during the process of placement of composite resin strip crowns. Placement of composite in increments can help improve the extent and quality of polymerization by increasing the depth of the cure. However, this prolongs the chairside-time and hence the possibility of moisture contamination, thus leading to a greater risk of failure of the resin restoration^{27,28}.

Whilst this can be overcome by using laboratory fabricated composite resin crowns they require two appointments: one for caries removal and preparation of the affected tooth, followed by the taking of an impression with a polyvinylsiloxane material and temporization of the tooth. The second appointment is for cementation of the composite resin crown following indirect fabrication in the laboratory²⁷. Nevertheless, no clinical trials have been reported in the literature. Hence, the long term success of this treatment option is uncertain.

Co-polyester crowns

This type of crown consists of a co-polyester material that is flexible, so the length can be adjusted and trimmed. The flexibility

of this material allows for the crown to accommodate the great variability in tooth size and shape and to facilitate adaptation to the teeth, especially in a pre-cooperative child. The co-polyester crown shell must be primed with a plastic primer material provided prior to placing the composite resin and left on the tooth to cure. Failure is often due to the stripping of the crown form under heavy wear and discolouration of the margins²⁹.

Artglass crowns

Artglass is a composite resin material with 75% filler and microglass particles that are claimed to produce greater durability and better aesthetics. A pilot study carried out in 2000 showed that 83% were judged to be clinically ideal after two years. The failures were associated with the bonding²⁸.

Zirconia crowns

Zirconia crowns have been used in the permanent dentition as a definitive restoration with predictable success³⁰. Recently, a randomised controlled in vivo trial in 2014⁸ compared zirconia crowns, pre-veneered SSC and composite resin strip crowns in the maxillary primary teeth over a period of 6 months. The retention rate was 100% for zirconia crowns, 95% for SSC and 78% for composite resin strip crowns⁸. However, the composite resin strip crowns in this study were placed without a rubber dam.

Resin modified glass ionomer cement (RMGIC) strip crown

RMGIC strip crowns are reported to be interim therapeutic restorations with good durability and aesthetics. The placement of a RMGIC strip crowns is minimally invasive and can be carried out in knee-to-knee position, especially in children with limited co-operation. Any soft caries can be removed with hand instruments. The correct sized crown form is then selected and cemented on the tooth using RMGIC. The RMGIC is then cured and the crown form matrix removed. This type of restoration shows promising results with the two restorations intact at 9-months and 2-year follow-up in one case report³¹.

Crowns for posterior teeth

Preformed metal crowns were independently described by Engel³², and by Humphrey³³ in 1950. SSC are easy to place, durable and have a mean annual failure rate of only 4.5%. It is noteworthy that this is a combination of both true and false failures³⁴. However, the use of metal crowns is not preferred by some parents^{35,36} and hence prompted the

development of tooth coloured restorative options for primary molars.

Open-faced stainless steel crowns

A number of reports in the literature suggest cutting a facial window in the SSC, followed by cement removal in this area, to make the underlying tooth tissue visible^{7,12,37}. Open-faced SSC's have high success rates, although they were found to display poorer aesthetics when compared to veneered crowns at the end of an 18-month follow-up period⁹.

Epoxy paint crowns

Another type of aesthetic crowns is the aluminium preformed metal crown with epoxy paint over the external surface. Aluminium crowns are relatively soft and this may create a problem with long-term durability. Moreover, on the posterior teeth, the white coating can easily wear off in the stress bearing areas^{38, 39}.

Pre-veneered crowns

Pre-veneered crowns can be an aesthetically pleasing alternative to SSC's. Veneering is one of the methods used to make the SSC's more aesthetically pleasing; different techniques and materials are used for veneering such as thermoset resin, PanaviaTM ex and silicoating^{40,41}.

Fuks et al.⁴², in a pilot study involving 22 crowns reported no significant differences between the SSC's with and without aesthetic facings, in terms of marginal extension, occlusion, proximal contacts, crown adequacy and bone resorption at a 6-month follow-up period. However, significantly poorer periodontal health was observed in relation to crowns with aesthetic facings⁴². Furthermore, after 4 years, 10 out of the 11 remaining crowns in the same study exhibited partial loss of the veneer⁴³.

Composite resin strip crowns

Ram & Peretz⁴⁴ described a method of placing composite resin strip crowns on severely broken down primary mandibular molars. No long-term follow-up has been reported for this technique. Nevertheless, if there is strong opposition from a parent or child to a SSC, and a desire is expressed for a more aesthetically pleasing restoration then the composite resin strip crown may be considered as a viable alternative⁴⁴.

Preformed composite resin crowns

ProTempTM crowns have been marketed for the use on primary molars⁴⁵. It is a pre-formed composite resin crown that can be cemented with a resin-based luting material. There are no clinical studies available on the use of these in the primary

dentition; however, the colour stability of these crowns has been reported to be less than ideal in the permanent dentition⁴⁶.

Zirconia crowns

Zirconia crowns for the restoration of the primary molars are a recent introduction and long-term clinical data is unavailable. Nevertheless, as a greater amount of tooth structure should be removed to fit the zirconia crowns, it is suggested to be ideal for primary molars that have undergone a pulpotomy or pulpectomy⁴⁷. An in-vitro study published in 2014 reported that the pre-veneered crowns resist significantly more force compared to zirconia crowns⁴⁸.

Discussion

Quality of evidence:

The RCT compared the clinical outcomes of three aesthetic full-coronal restorations (composite resin strip crowns, pre-veneered SSC and pre-fabricated zirconia crowns) that were used to restore carious and traumatised maxillary primary incisor teeth. The reported retention rates were highest for zirconia crowns (100%) followed by pre-veneered SSC (95%) and composite resin strip crowns (78%). The limitations of this RCT were (i) the investigators failed to account for the drop-out rates of approximately 15%, (ii) did not manage the clustering in their statistical analysis as their randomization was by child and not by tooth, (iii) short-term follow-up of only 6-months, (iv) lack of radiographic assessments, (v) no rubber dam isolation, and (vi) small sample size. Therefore, one should exercise caution when interpreting these findings.

Leith & O'Connell, in 2011¹⁰ evaluated the success rates for NuSmile[®] and KinderKrownTM crowns on primary molar teeth and determined the level of parental satisfaction. The overall clinical success rates for both crown types were 100% crown retention, 81% had intact veneer facings and 83% were free of gingival inflammation. The overall radiographic success rate was 81%. Furthermore, parental satisfaction was deemed to be excellent with a mean score of 9.3 out of 10¹⁰.

Yilmaz & Koçoğullari, 2004⁹ compared the clinical success of SSC's on posterior primary teeth with (i) an open facing or (ii) a veneer. After 18 months, the reported success rates were 95% and 80% respectively. Although the open-faced SSCs exhibited a higher success rate than the veneered SSC's the results were not statistically significant⁹.

Currently, a variety of aesthetic crown restorations for primary teeth are available

in the market. However, due to the lack of high quality scientific data, it is difficult to compare the different restorative options. Composite resin strip crowns appear to be the most widely accepted and used restorative option. However, zirconia crowns are now considered to be the most aesthetic paediatric dental crowns. Furthermore, these crowns offer a new approach and serve as an alternative to restore the natural appearance of a child's primary teeth compromised by dental caries and/or dental trauma.

Conclusion

There is no scientific evidence in the literature to support of the superiority of one tooth coloured crown over the other.

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Table 1: The advantages and disadvantages of tooth coloured crowns for primary anterior teeth.

Crown type	Brand names	Advantages	Disadvantages
Polycarbonate	3M™ ESPE™, Unitek™, Solodent	<ul style="list-style-type: none"> Moderately good aesthetic outcome Poor periodontal response 	<ul style="list-style-type: none"> No resistance to abrasive forces Not as aesthetic as other options
Performed Metal Crowns	Unitek, 3M™ ESPE™	<ul style="list-style-type: none"> Durable Easy to place Minimal tooth structure removal Good periodontal response 	<ul style="list-style-type: none"> Poor aesthetic outcome
Open-faced SSC		<ul style="list-style-type: none"> Easy to place Minimal tooth structure removal 	<ul style="list-style-type: none"> Failure due to poor bonding of resin to metal Cannot be re-shaped
Pre-veneered SSC's	Kinder Crown®, NuSmile®, Cheng Crowns, Flex White Faced Crowns, Dura Crowns™	<ul style="list-style-type: none"> Good aesthetic outcome Minimal tooth structure removal required Not affected by blood or saliva 	<ul style="list-style-type: none"> Failure of resin veneer common Available in two shades only Expensive Minimal crimping Cannot be re-shaped Poor periodontal response
Composite resin strip crowns	3M™ ESPE™	<ul style="list-style-type: none"> Good aesthetic outcome Durable if done correctly Multiple shades can be used Easy to repair Fits into crowded space Inexpensive 	<ul style="list-style-type: none"> Technique sensitive Adequate enamel essential for bonding Cannot mask discolouration well
Co-polyester crowns	Pedo Jacket crown	<ul style="list-style-type: none"> Good aesthetic outcome 	<ul style="list-style-type: none"> Only one shade Cannot be trimmed or re-shaped
Laboratory fabricated (indirect) composite crowns	Life Like Crowns	<ul style="list-style-type: none"> Good aesthetic outcome Better polymerization Multiple shades can be used Can be re-shaped 	<ul style="list-style-type: none"> Two appointments required Temporary restoration may be required
Artglass crowns		<ul style="list-style-type: none"> Good aesthetics 	<ul style="list-style-type: none"> High failure rate due to bonding issues
Zirconia crowns	EZ-Pedo™, Cheng Crowns, NuSmile®, Kinder Crown®	<ul style="list-style-type: none"> High standard of aesthetic outcome Colour stable 	<ul style="list-style-type: none"> Limitations in shades Removal of significant amount of tooth structure Longer chair time Lack of data to assess durability Adequate moisture control required
RMGIC strip crowns	3M™ ESPE™	<ul style="list-style-type: none"> Adequate aesthetic outcome Minimally invasive so easy to perform 	<ul style="list-style-type: none"> Longevity uncertain Cannot be used for badly broken down teeth

Table 2: The advantages and disadvantages of tooth coloured crowns for primary posterior teeth.

Crown type	Brand names	Advantages	Disadvantages
Open-faced SSC's		<ul style="list-style-type: none"> Easy to place Minimal tooth structure removal 	<ul style="list-style-type: none"> Failure due to poor bonding of resin to metal Cannot be re-shaped
Epoxy Paint Crowns	Pedo Pearls®	<ul style="list-style-type: none"> Moderate aesthetic outcome 	<ul style="list-style-type: none"> Poor periodontal response Paint chipping over time
Pre-veneered SSC's	Kinder Crown®, NuSmile®, Cheng Crowns, Flex White Faced Crowns, Dura Crowns™	<ul style="list-style-type: none"> Good aesthetic outcome Minimal tooth structure removal required Not affected by blood or saliva 	<ul style="list-style-type: none"> Failure of resin veneer common Available in only two shades Expensive Minimal crimping possible Cannot be re-shaped
Composite resin strip crowns	3M™ ESPE™	<ul style="list-style-type: none"> Good aesthetic outcome Multiple shades can be used Easy to repair Fit into crowded space Inexpensive 	<ul style="list-style-type: none"> Technique sensitive Adequate enamel essential for bonding
Laboratory fabricated preformed composite crowns	ProTemp™	<ul style="list-style-type: none"> Good aesthetic outcome Moisture contamination not critical 	<ul style="list-style-type: none"> Limited sizes Unable to crimp
Zirconia crowns	EZ-Pedo™, Cheng Crowns, NuSmile®, Kinder Crown®	<ul style="list-style-type: none"> High standard of aesthetic outcome 	<ul style="list-style-type: none"> Limitations in shades Removal of significant amount of tooth structure Longer chair time Lack of data to assess durability

2015 Louise Brearley Messer ANZSPD Under-graduate Essay Competition

Deep dental caries – to leave or to remove? New perspective on an old theme

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Abstract: The traditional approach to treating deep carious lesions has involved complete removal of all soft, demineralized dentine. Equipped with a more in depth understanding of the dynamic nature of the carious process, many studies have examined more conservative techniques that involve sealing carious dentine in the tooth. These methods include the stepwise technique, partial caries removal and the Hall technique. At present, the literature suggests that partial caries removal in symptomless primary or permanent teeth reduces the risk of pulpal exposure, however it is still unclear whether it is necessary to re-enter and excavate further in the stepwise procedure. The Hall technique, used for the restoration of caries in primary molars, has illustrated success, although more research is required to support this method. Overall, these techniques have showed clinical advantage over complete caries excavation. Despite these findings, dentists remain hesitant to incompletely excavate cavities. The literature would benefit from long-term clinical trials to determine the sequelae of sealing carious dentine in teeth.

Keywords: deep caries; partial caries removal; stepwise; hall technique; pulpal exposure.

Word Count: 2887 (excluding references)

Introduction

Historically, caries was seen as a progressive disease that eventually destroyed a tooth unless there was intervention. It is now recognized that dental caries is a dynamic process.¹ The natural biofilm on teeth contains bacteria that metabolise carbohydrates and excrete acids that partially dissolve tooth structures. As this process continues, calcium and phosphate diffuse out of the tooth, which can lead to tooth cavitation.² Alternatively, the addition of calcium, phosphate and fluoride can reverse the demineralization on non-cavitated lesions. The process of demineralization and remineralisation is dynamic, and occurs frequently throughout the day

resulting in cavitation, reversal or repair.¹

When the caries balance favours bacteria, cavitation in the tooth can occur and the patient will be unable to clean the affected area.² At this point, the dentist must restore the lesion to enable patient cleaning and to halt the caries process. The objectives of restoring lesions from a cariologic point of view are to arrest the carious process, provide an adequate base for the restorative material, and produce a filling that the patient can clean.²

Traditionally, restoration of teeth involved the complete removal of the soft demineralized dentine in order to stop the decay.³ However, in the 1970's research by Fusayama identified two separate carious dentine layers, an outer "infected layer" incapable of remineralisation and an inner "affected layer" that can remineralise.⁴ As a result, many practitioners aimed to remove the infected dentine and leave the affected dentine to remineralise, however clinically distinguishing between infected and affected is difficult, and can often lead to over or under excavating cavities.²

Recent research has supported claims that leaving small amounts of infected dentine in a cavity does not result in caries progression or pulpal symptoms provided the overlying restoration has a perfect seal removing bacterial substrate.⁵ This method adopts the philosophy that the driving force

behind caries progression is the metabolic activity in the biofilm at the tooth surface and modifying or altering this biofilm may be enough to arrest or halt this process.⁵

The debate surrounding how much tissue must be removed in order to arrest the caries process is not new.³ Over a century ago, the pioneers of dentistry G. V. Black and John Tomes represented opposing sides of the debate, with John Tomes supporting a more conservative approach arguing that it is better to leave discoloured dentine to protect the pulp than to risk sacrificing the tooth, while G. V. Black argued that it is better to expose the pulp than to leave it covered with softened dentine.⁵

The decision to remove all, some or none of the infected tooth structure is perhaps most critical for dentists when the tooth has deep caries where the pulp is at risk of exposure or infection by disease progression. Defining deep caries is often a clinical judgement, usually described as caries that radiographically penetrates to within $\frac{3}{4}$ of the dentine.⁶ The current climate of Minimally Invasive Dentistry supports and encourages conservative removal of tooth structure⁷ with sound evidence-based literature directing best practices. Recent studies have been dedicated to examining the success of incomplete caries removal including the stepwise technique, partial caries removal and the Hall technique. These methods, along with clinical and practical implications of each, will be discussed in detail below.

Stepwise Technique

In stepwise excavation or "two step excavation," only part of the soft carious dentine is removed in the first visit during the acute phase of caries progression.^{5,8-13} The cavity is temporarily restored and then re-opened after a period of time, usually weeks or months, where further excavation is performed and a definitive restoration is placed.^{5,13} The stepwise technique aims to arrest the

progression of the lesion in the first step and allow reparative dentine to be laid. The objective is to make pulp exposure, and the subsequent need for pulp treatment, less likely.

Six randomized control trials have examined the success rate of this technique.^{11,12,14-16} Four compared stepwise to complete caries removal and in all cases stepwise had significantly higher success rates, ranging from 74-89%.^{11,12,14,16} Interestingly, in both groups the majority of failures were attributed to pulp exposures. Two studies compared stepwise to the partial caries removal technique, the results of which will be discussed in detail below. One case study reported 100% success in two-step removal, however this higher success may be attributed to the relatively

shorter follow up period of 6-7 months compared to 12-36 months in the above-mentioned control trials.

Majority of the literature has focused on the stepwise removal of deep caries in permanent teeth.^{11,14,15,17} However, the studies that included¹⁶ or exclusively¹² examined primary molars found no statistical difference in success of treatment.¹⁶

Overall, the literature suggests that retaining carious dentine did not interfere with pulp vitality and had distinct advantages of less risk of pulp exposure^{11,12,16} a topic which will be examined in subsequent paragraphs.

Partial Caries Removal (PCR)

Initial research has illustrated that cariogenic bacteria, once isolated from their source of nutrition, either die or become inactive.^{8,15,17-19} Clinical, microbiological, radiographic and laboratory analyses have shown that the infected caries left underneath restorations is inactive, exhibiting increased hardness, decreased moisture, reduced bacterial infection and increased radiographic density.^{8,14,15,17,18,20-23}

Three randomized control trials have examined the microbiology of the dentine when partial caries removal, complete caries excavation and stepwise techniques are used.^{15,18,21} All of the studies found higher levels of microorganisms in partial caries removal compared to complete caries excavation. However, the sealed carious dentine was similar²¹ or less infected than the dentine remaining after complete caries excavation.^{15,18} These findings challenge the guiding principle of “complete caries removal” given that cariogenic bacteria is evident in dentine following complete excavation.^{15,18} The quality of bacteria was also found to change, with sealed dentine having a significant reduction in aciduric and cariogenic bacteria content.²¹

In light of these findings, many researchers have questioned whether the second step of the stepwise technique is necessary.²¹ If the caries process has arrested, then the second visit to re-open the cavity is not only unnecessary discomfort to the patient, but again risks complications such as pulp exposure.¹⁶ Many practitioners therefore use the partial caries removal (PCR) technique where most but not all of the infected dentine is removed and then a final restoration is placed with or without a pulpal liner. This eliminates the

step of re-opening the cavity to remove the remaining affected dentine. For this reason, the technique is often referred to as “one step” or incomplete caries removal.

Nine randomized control trials have examined the success rate of PCR. Results consistently reported high success, with figures including 100%²¹ success of cases at 6 months, 83-100%^{15,18,23} at 12 months, 90-100%²⁴ at 24 months and 79-91%^{15,25} at 36 months. Four of these studies compared partial to complete removal and in all cases PCR outperformed complete. Complete removal was found to be successful in 89%²¹ of cases at 6 months, 72-96%^{16,23,26} at 12 months and 69%²⁴ at 24 months. Three trials compared PCR with the stepwise technique and similarly, PCR consistently exhibited higher success rates reporting 90-93%^{15,16} success at 12 months, and 69%¹⁵ at 36 months. The remainder of trials examined the success of different materials used during partial caries removal and found similar overall success rates of 100%²⁷ at 24 months, and 80%²⁵ at 36 months. Finally, case studies have supported these findings.^{20,28-30}

Both primary and permanent teeth have been examined in the literature, and there appears to be no difference in success rates between these types of teeth. Two studies included both primary and permanent molars and concluded that there was no statistical difference between them.^{16,30} However, in the primary dentition, tooth type was found to influence failure rates. Primary first molars were identified as significantly more likely to fail partial caries removal treatment than primary second molars.^{28,31} Finally, as it relates to primary teeth, retrospective studies have identified that clinical and radiographic success rates of PCR are similar to those of pulpotomies in primary teeth.^{28,29}

Pulp exposure and other failures

The rate of pulp exposure during deep caries removal varies considerably in the literature making generalised conclusions difficult. Some studies have reported exposure during complete excavation to have occurred in 22%^{16,21} 29%¹⁴ 28%²⁴ 40%¹¹ and 52%¹² of cases. These figures are lower for the stepwise technique with incidence rates of 8%¹⁶ 14%¹² and 18%^{11,14} Finally, partial caries removal resulted in the least number of pulp exposure with occurrence in 0%²⁶ 1.5%²⁴ 4%²⁰ and 6%¹⁶ of cases. Recent Cochrane reviews,^{3,32} a systematic review and meta-

analyses,³³ and other publications^{34,35} have concluded that the use of partial caries removal significantly reduces the risk of pulpal exposure compared to complete caries removal.

The significance of pulp exposure is highlighted by the findings of a recent randomized control trial¹⁴ which found low survival rates of 38% in adults and 31-35% of primary teeth that had pulpal exposure.

Not surprisingly, majority of failures in the management of deep caries has been pulp related, including pulpitis or abscess formation.^{14-16,19,22,25,27,29,30} This highlights the importance of detailed clinical assessment for signs of pulpal symptoms prior to treatment, as this may contribute to higher rates of failure.³⁶

Hall technique

Stainless steel crowns (SSC), or “preformed metal crowns” are considered the standard of care for restoring large carious lesions in primary molars.³⁷ Traditionally, this is performed by administering anaesthetic, removing carious dentine and preparing the tooth to enable seating of the crown. This can present significant challenges for the young patient.³⁸ An alternative technique, known as the “Hall technique,” embraces the notion that the caries process can be slowed, arrested or even reversed in a sealed environment. It involves cementing a SSC without any anaesthetic or removal of tooth structure.³⁹

Three randomized control trials have examined the success of the Hall technique and in all three cases it has outperformed conventional methods.³⁹⁻⁴¹ A 98%⁴¹ success rate was identified at 12 months, 93%³⁹ at 23 months and 92%⁴⁰ at 48 months. For the compared conventional restorations, success was lower, occurring in 42% of cases³⁹ at 23 months, and 52%⁴⁰ at 48 months. The authors in these studies noted that the comparative success of conventional restorations is lower than what would be expected, and suggest it may be attributed to the use of glass ionomer in two surface restorations, a practice shown to be less successful than those placed with resin based materials.^{39,40}

One retrospective study³⁷ supported these findings, citing success in 97% of teeth restored with Hall technique at 15 months, and a similar 94% success in traditional SSC preparation. Another longer termed study found Hall technique

successful in 73% of cases at 36 months, and 68% at 60 months.³⁸ When this study adjusted for cases where crowns have been displaced, but were able to be successfully re-cemented, success at 36 months improved to 86%.

Interestingly, two of the control trials utilized the split mouth technique, whereby one patient had two different treatment methods for similar lesions in the mouth.^{39,40} This has the advantage of enabling children and parents to report on overall experiences of two different restorative techniques. One study of this design reported that 77% of children, 83% of parents and 81% of dentists preferred Hall technique over conventional restorations,³⁹ whereas another found no preference between the two methods.⁴¹

Indirect pulp capping (IPC)

A major problem when investigating partial caries removal in clinical studies, is that it is impossible to measure degree of excavation.³³ Some authors suggest that there is a distinction between indirect pulp capping (IPC) and partial caries removal in that IPC involves more dentine removal than PCR.^{2,6} This is, of course, a clinically subjective distinction. A practitioner may believe that they are very close to exposing the pulp and consider the treatment IPC, when in fact the pulp may be protected by 2 mm of tooth structure, arguably more appropriately defined as PCR. It is for this reason that these two terms are often used interchangeably, or at least in similar circumstances. Nevertheless, indirect pulp capping occurs upon placement of a medicament liner, and therefore can be an inherent part of a partial caries or stepwise technique.

Calcium hydroxide has traditionally been used as the liner material of choice for deep carious lesions, primarily due to its alkaline pH which is not only bactericidal, but also irritates the pulp causing the formation of reparative dentine.⁴² One disadvantage of conventional calcium hydroxide is the inability of resin-based restorative materials to bond to it, stressing the importance of margins that are free of lining material. A recent Cochrane review, which unfortunately only identified four suitable trials, concluded that there is no evidence to suggest that there is one type of indirect pulp capping material that has more favourable outcomes in terms of clinical symptoms.⁴³ The materials studied included Ledermix, glycerhetinic acid/antibiotic mix, zinc oxide eugenol, calcium hydroxide, Cavitec, Life, Dycal,

potassium nitrate, dimethyl isosorbide and polycarboxylate cement. Others studies have supported these findings, concluding that calcium hydroxide had comparable success rates to gutta percha²⁵ and resin adhesive²⁷ liners.

In contrast, a recent systematic review of the failure of incompletely excavated teeth identified a that teeth lined with calcium hydroxide appeared to have higher failure rates than those restored directly.³⁶ Others have concluded that resin modified glass ionomer liners were of similar biocompatibility to calcium hydroxide, with similar success rates, but with the advantage of preventing microleakage.²²

Pulp Treatment

If pulp exposure does occur during caries removal, the choices for treatment are direct pulp capping, pulpotomy, pulpectomy or extraction.⁴⁴ A direct pulp capping procedure is performed by placing a medicament over the exposed pulp, temporarily restoring the tooth and reassessing for symptoms of pulp pathology.⁴⁵ A pulpotomy is the removal of the pulp tissue from the pulp chamber whereas a pulpectomy is the complete removal of all pulp tissue from the chamber and canals.⁴⁵

There are numerous materials and medicaments that can be used for pulp treatments including calcium hydroxide, formocresol, ferric sulphate and mineral trioxide aggregate (MTA).⁴⁴ A recent Cochrane review examined the results of 14 clinical trials and conclude that in the case of the pulpotomy, a procedure almost exclusively performed on primary and immature teeth, there is no one superior medicament.⁴⁵ The authors did, however, go on to state that there is evidence to suggest that MTA and ferric sulphate may be preferable.

With regards to direct pulp capping medicaments, there are limited clinical trials to examine.⁴⁵ One case study has cited increased success of MTA over calcium hydroxide.^{46,47} Another reported long- termed success of teeth treated with MTA, a rate of 91.3% at 3.6 years.⁵³

Current practices

Despite evidence of greater success,^{11,12,14-16,23,26} fewer pulp exposures,^{11,12,16} shorter operating time,²⁴ patient preference³⁹ and improved cost effectiveness,⁴⁸ practitioners remain hesitant to adopt incomplete caries removal techniques.^{15,49,50} Studies in

North America⁴⁹ and Brazil⁵⁰ identified that the first choice for the treatment of deep caries was complete caries removal in a single session, even if there is risk was a perceived risk of pulpal exposure.

Conclusions

Minimum intervention dentistry is the modern medical approach to the management of caries.⁷ When deep caries is present, conservative caries removal should be exercised to maximize the repair potential of the tooth and retain tooth structure.⁷ At present, the literature suggests that partial caries removal in symptomless primary or permanent teeth reduces the risk of pulpal exposure, however it is still unclear whether it is necessary to re-enter and excavate further in the stepwise technique.^{3,32} The Hall technique, for the restoration of caries in primary molars, has illustrated success, although more research is required to support this method.³² Overall, these methods have shown clinical advantage over complete caries excavation. In all cases, correct clinical diagnosis of the pulp status prior to restoration is imperative. Moreover, caries can only be arrested so long as the restoration seal prevents substrate ingress. Without regular clinical reassessment, these lesions are at risk of reactivating at an advanced state of progression.

The rate of success in all of the above-cited studies is limited by their restricted follow up period. In clinical practice, a restoration is not considered a success if it has a lifespan of only 12, 24 or 36 months, particularly in the permanent dentition. The long-term sequelae of leaving carious dentine in sealed cavities are presently unknown. Perhaps this is what is needed to convince the current dentist population of the advantages of more conservative approaches to caries management.

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Branch Report

New Zealand



1907 First Dental School



Current Staff Club

The formal meetings of the New Zealand Branch have not followed the usually format. We held our 2015 AGM in Adelaide in conjunction with ANZSP Biennial 25th Congress and our 8th annual study day was held in Dunedin on Saturday 13th February 2016. Most appropriately the venue was New Zealand's first Dental School. This building, in its latest incarnation, is now the University of Otago Staff Club.

1907 First Dental School Current Staff Club

The building was described in the New Zealand Dental Journal (1908): "The University of Otago Dental School... is a scholastic-looking edifice on the banks of the Water of Leith ..."

The study day provided a great mix of social and intellectual interaction. The presenters included Stephen Robertson, Curekids Professor of Paediatric Genetics and Craniofacial Anomalies. Stephen delivered an informed and inspiring

lecture "Genes and Genomes – Causes and Consequences."

Heather Keall's interactive presentation "Lessons from the Mouse" challenged us to look at our work environments through the eyes of the child. Could these environments be improved if we used some of Disney's vision? 'Magic you can take anywhere; A little imagination, empathy, and very little cost; More fun for the patients and more enjoyable for us.' (Heather Keall). Our paediatric dental postgraduates benefited by presenting to a collegial, knowledgeable and astute audience.

The NZ branch is delighted to able to host the RK Hall Lectures series The Art and Science of Paediatric Dentistry 26th & Monday 27th March 2017. The keynote speaker is the Secretary General of the International Association of Paediatric Dentistry, Dr Ari Kupietky. Ari is a practicing paediatric dentist in Jerusalem and teaches part time at the Department of Pediatric Dentistry

in the Hebrew University Hadassah School of Dental Medicine. He is a noted speaker and author of numerous articles and textbook chapters. Ari will be supported by local paediatricians, and an oral medicine specialist. A registered social worker promises to investigate the relationship between "Hippocrates and the smart phone".

No professional group can conduct successful study days or arrange an international lecture series without an effective committee. My grateful thanks for the many selfless hours by Craig, our secretary treasurer, and the rest of the Branch's dedicated committee members.

Registrations for our RK Hall Lecture series open at the end of October 2016 – get organised now so you can benefit from early bird registration. Look forward to seeing you at The Art and Science of Paediatric Dentistry in Auckland in March 2017.

Alison Meldrum

Branch Report

South Australia

2016

2016 has been a good year for the SA Branch. Throughout the year, our meetings have been well received and attended.

Our first meeting of the year, in conjunction with the Australian Prosthodontic Society SA Branch, was very well attended and enjoyed. There are plans for future meetings with other societies.

Professor Ray Russo presented at our second meeting, providing us insight to the multi-disciplinary involvement of the Paediatric Rehabilitation team at the Women's and Children's Hospital. We were honoured with a sneak peak of Australia's first 'Centre for Robotics and Innovation', established at the Women's and Children's Hospital, Adelaide. Dr Ninna Estrella Yuson and Dr Steve Langford discussed "Interceptive Orthodontics: a Paediatric Dentist's and Orthodontist's Perspective".

For our final meeting of the year, we heard from Emeritus Professor Alastair Goss regarding "Litigation and Expert Witness cases related to Paediatric Dentistry". A big thanks to the SA branch committee for their continued involvement and support. On behalf of the committee, we look forward to seeing you next year.

Gwendolyn Huang

Branch Report

Western Australia

The West Australian Branch has had a wonderful 2016. The second half of the year included a highly successful and well attended Scientific Meeting with invited guest speaker, Professor Helen Rodd and an array of accomplished local speakers. This was followed by a postgraduate evening in September where our paediatric postgraduate students, and an endodontic postgraduate student presented interesting case reports and areas of their research. All presentations were performed to a very high standard, and included:

- A case of dental trauma and dilemma which comes with it – Dr Hari Ramineni (Endodontic postgraduate)
- Ghost teeth: Regional odontodysplasia – Dr Lisa Bowdin (Paediatric postgraduate)
- Chalky teeth under the micro-CT – Dr Chaturi Neboda (Paediatric postgraduate)
- Clinical dilemmas in the management of facial cellulitis following dental trauma – Dr Jilen Patel (Paediatric postgraduate)

- Dental manifestations and oral care experiences for individuals with Rett Syndrome – Dr Yvonne Lai (Paediatric postgraduate)

The last meeting for the year was our AGM and three-course dinner, held at Linton and Kay Art Gallery in Perth's City Centre. We were dining, surrounded by beautiful paintings and sculptures... what a treat! This event was subsidised by ANZSPD (WA), and proved to be a unique evening.

The ANZSPD WA calendar for 2017 is shaping up nicely with Professor Lars Andersson accepting our invitation to present at our Scientific Meeting on the 15 September 2017. This day will be preceded by an ANZSPD (WA) sponsored Postgraduate Seminar for all Paediatric Postgraduate students.

Our Calendar for 2017 includes:

- **Friday 17 March:**
Partners Evening
- **Thursday 25 May:**
Postgraduate Presentation and Dinner

- **Friday 21 – Saturday 22 July:**
Mid-Winter Conference at Pullman Bunker Bay Resort

- **Thursday 14 September:**
Postgraduate Seminar with Professor Lars Andersson

- **Friday 15 September:**
Scientific Day "Managing the complications of dental trauma – an interdisciplinary approach".

- **Friday 27 October:**
End of Year Function and AGM

We would encourage and invite all ANZSPD members to join us. Please check the ANZSPD website for updates and registration details. Wishing everyone a great end of year and fabulous festive season.

Vanessa William

Branch Report

Victoria

The ANZSPD Victorian branch had another busy year in 2016. Our first scientific dinner meeting was held on the 3rd of March at University House. Our guest speaker, orthodontist Dr Albert Wong, updated registrants with current evidence regarding the use of space maintainers and space maintenance in the developing dentition. On the 4th of August, our second scientific dinner meeting was held at the Woodward Centre. We were privileged to have a joint presentation by Associate Professor Nicky Kilpatrick and Dr Susie Gibb, to provide insight into the role of "The Cleft Team" at the Royal Children's Hospital of Melbourne and how they care for and manage children with Cleft lip and/or palates and their associated conditions. We also presented the winner of the Des Crack Prize to Ms Sheryl Chew, a final year dental student with highest aggregate score in paediatric dentistry.

Our final scientific meeting, the Elsdon Storey Memorial Lecture, was held on the 15th of October. We invited an interstate guest speaker, Dr Geraldine Moses, who provided our registrants with an overview of updates in pharmacology with clinical relevance to our current practice for prescribing medications for the paediatric dental population.

With the renewed interest in our 2016 program, the ANZSPD Victorian Branch 2017 program will follow a similar format. The program will include two dinner meetings in February and July, with an additional scientific on a Saturday in October to coincide with our Annual General Meeting. The committee is currently working hard to finalise the program with a variety of topics and speakers.

Dr Evelyn Yeung

Extravasation mucoccele of the tongue (A Case Report)

Dr Jacquelyn Fechney

BDS (Otago University)

University of Sydney DCLinDent Student (Paediatric Dentistry)

Introduction

Oral soft tissue lesions in children are fairly common with most literature coming from the review of epidemiological and histopathological data obtained from oral biopsies which have been completed within a particular pathology service. Majority of lesions in the oral cavity of children are benign with less than 10% found to be malignant¹. These lesions may be categorised into inflammatory/reactive lesions (e.g. periapical granuloma, fibrous hyperplasia, pyogenic granuloma, peripheral ossifying fibroma), cystic lesions (e.g. dentigerous, radicular, epidermoid and traumatic bone cysts), salivary gland pathologies (e.g. mucocèles; this category is often combined with reactive lesions), tumour-like lesions; odontogenic (e.g. odontoma, ameloblastoma, adenomatoid odontogenic tumour) and non odontogenic (e.g. papilloma, traumatic fibroma, neurofibroma, haemangioma, pleomorphic adenoma), malignant neoplasms (e.g. langerhans cell histiocytosis, rhabdomyosarcoma) and other lesions (e.g. dental pulp and periodontal pathologies)²⁻⁴.

Inflammatory/reactive lesions, cystic lesions and salivary gland pathologies appear to be the most common type of lesions identified^{3,4}. Within these categories the mucoccele is often reported to be the most frequent (13.5% of all paediatric oral lesions), followed by dentigerous cyst and fibrous hyperplasia⁴. Papillomas and traumatic fibromas are also relatively common³. Of all oral lesions biopsied the periodontium is the most prevalent site, followed by the lips and oral mucosa. Other less frequent biopsy sites include the tongue, palate and floor of the mouth³.

Mucocèles, as mentioned are the most common lesions of the oral mucosa and are known to occur in varying locations on mucosal surfaces including the lip, tongue, buccal mucosa and palate^{3,5-7}. Most commonly they arise on the lower labial mucosa and it is thought that it is because of the predisposition of this site to trauma^{6,8}. Mucocèles generally present as soft, superficially located, asymptomatic swellings, commonly with a

polypoid appearance, ranging from a few millimetre up to a few centimetre in size, and vary from deep blue to normal pink in colour depending on the diameter and proximity to the overlying surface. The deep blue colour often appears due to tissue cyanosis and congestion of vessels, as well as the translucent appearance of the underlying accumulation of fluid⁹. Often patients report fluctuation in size and many experience fluid discharge from the mucoccele⁹. This case report describes one such lesion.

Case Report

A fit and healthy six year old girl presented to the Department of Paediatric Dentistry, Westmead Centre for Oral Health (WCOH) for review of dental trauma that had occurred 8 weeks earlier. The acute management of the trauma was completed through the Emergency Department at the Childrens Hospital Westmead (CHW) using inhalation sedation and local anaesthesia. The child had sustained concussion injuries to her permanent maxillary central incisors (teeth 11 and 21), subluxation injury to her primary maxillary left lateral incisor (tooth 62) and a gingival degloving of the upper anterior region. On review these teeth were asymptomatic, healing was unremarkable and both the child and her mother reported no other concerns. Thorough examination at this appointment revealed a 'lesion' on the ventral surface of the tongue. When probed the girl's mother reported noticing the lesion approximately 6 months earlier. She thought the lesion had disappeared, but recently it had returned and was much larger in size. The child stated that the lesion was asymptomatic, and she had no difficulties with eating or swallowing. However, her mother occasionally saw her playing with the lesion. There was no reported colour change or discharge from the lesion and no history of trauma to the area.

Extra oral examination was unremarkable, no abnormalities could be detected and she had good facial proportions with no asymmetry. Intra oral examination revealed an early mixed dentition with no active caries, mild dental crowding and

good oral hygiene. Teeth 11 and 21 were erupted and firm on palpation. However, soft tissue examination identified a solitary swelling on the ventral surface of the anterior two third's of the tongue. The lesion (as seen in figure 2) was located approximately 1cm from the anterior tip of the tongue along the mid line and measured approximately 7mm x 3mm x 3mm in size. It was pedunculated, fluctuant and similar colour to the surrounding mucosa. On palpation it was soft in consistency, freely mobile on all planes with firm attachment to the ventral surface of tongue. There was no tenderness or discomfort on palpation.

Following discussion with the patient's mother an excisional biopsy of lesion using inhalation sedation and local anaesthesia with subsequent histopathologic examination of specimen was planned for the following visit. Differential diagnoses included mucoccele, a traumatic fibroma and a lipoma.

An excisional scalpel biopsy of the lesion on the tongue was performed using inhalation sedation (slow induction, 35% nitrous oxide for 20 minutes, flow rate 5 l/min) and local anaesthesia (2% lignocaine with 1:100,000 adrenaline). The mucosa was sutured with 4/0 Vicryl™ and haemostasis was achieved. The child coped extremely well with the procedure. Post operative instructions were given to the patient and her mother, which included maintenance of oral hygiene with 0.12% Chlorhexidine mouth rinse (twice daily for 7 days), analgesia as required and a soft diet. The excision specimen was fixed in 10% Formalin and submitted to the NSW Health Pathology Lab West at Westmead Hospital for histopathological analysis.

Histopathology examination revealed a small polypoid portion of mucosa, surfaced with parakeratinising stratified squamous epithelium (figure 5). The epithelium was hyperplastic and showed spongiosis with focal inflammatory cell exocytosis. The central core of the specimen contained extravasated mucous with interspersed red blood cells and fibrinous material. The inspissated mucous contained scattered foamy



Figure 1: Dentition and associated soft tissue



Figure 2: Initial lesion on the ventral surface of the tongue



Figure 3: Surgical site following suture removal (1 week post operatively)



Figure 4: 6 month review showing no recurrence of the lesion

macrophages. The above findings suggest an extravasation mucocoele as the likely diagnosis.

A subsequent review appointment was scheduled for two weeks following the biopsy. The child reported being asymptomatic and her mother stated no analgesia was required. The surgical site was healing well. Oral hygiene was reinforced, a loose suture removed and topical fluoride application placed on the incipient enamel lesions in the interproximal regions of the primary molar teeth. The diagnosis (extravasation mucocoele) was discussed with the child's mother. A six month review was planned to ensure no recurrence of the lesion with new bite wing radiographs to monitor progression of incipient caries on her

primary molar teeth.

At the six month review the patient was asymptomatic and her mother had no concerns. The mucocoele had not recurred and no soft tissue pathology was evident. Bitewing radiographs were taken which showed progression of one carious lesion into dentine, which was subsequently restored with composite resin.

Discussion

Mucocoeles ('muco' meaning mucus and 'coele' meaning cavity) are defined as cavities filled with mucous, arising from salivary glands³. There are two documented subcategories of mucocoeles; the retention type and the extravasation type. Retention mucocoeles contain mucous retained by an epithelial lining,

whereas extravasation mucocoeles shows extravasated mucous within connective tissue⁶. Mucus is the secretory product of the minor (accessory) salivary glands and in the extravasation type leakage of the mucus fluid into the surrounding tissue occurs, hence there is no epithelial lining. This is different to retention mucocoeles where duct dilation and swelling occurs because of a narrowed duct opening which cannot allow adequate exiting of saliva⁸. The mucous extravasation type is the more common of the two and this possibly relates to a higher incidence of mechanical trauma, such as by biting, in this region^{5, 6, 10}.

As mentioned, mucocoeles are common, especially in young people. They are believed to be one of the most common

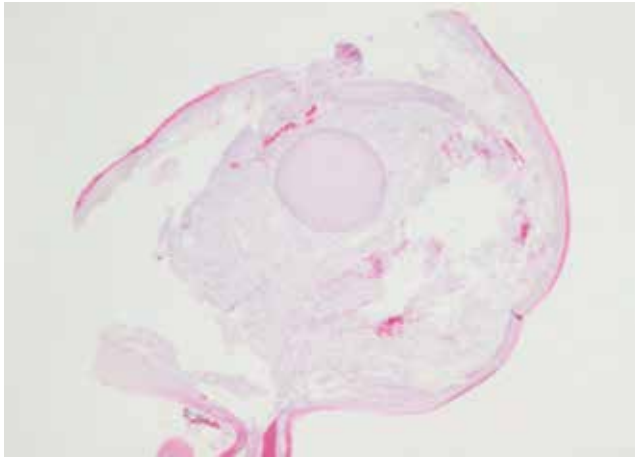


Figure 5: Section showing polypoid material with keratinised surface epithelium (signifying chronic irritation in an area of the mouth that is usually non keratinised) (low power)

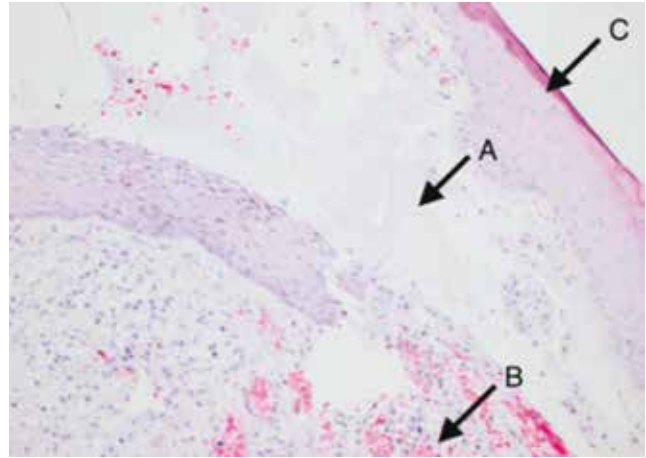


Figure 6: Slide showing extravasation mucous (A), increased vascularity (B) and parakeratosis (C) (low power)

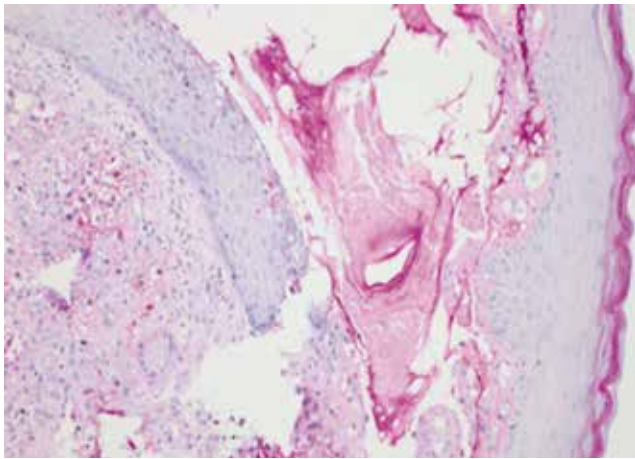


Figure 7: Periodic acid–Schiff–diastase (PAS-diastase) stain to show extravasation mucous (low power)

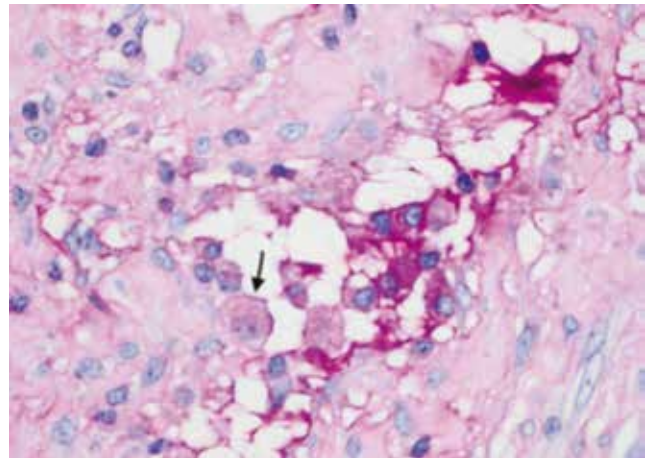


Figure 8: PAS- diastase stain to show mucin ingested by macrophages (high power)

benign soft tissue masses seen in the oral cavity⁸. It has been reported that majority of lesions occur in patients younger than 20 years^{11,12} and often there is a significant period of time between when the lesion is first observed until the patient seeks professional care. In this report it was almost six months prior that the lesion had first been observed. Even though the lower lip is the most common site, they can be seen more uncommonly situated on the ventral surface of the tongue⁶. Prevalence studies have shown mucocoeles situated on the ventral tongue to make up from 4.7-15.4% of all mucocoeles found in the oral cavity⁹⁻¹³.

The human tongue contains three groups of minor salivary glands: the glands of Weber along the border of lateral tongue, the glands of von Ebner surrounding the circumvallated papillae, and glands of Blandin and Nuhn embedded within the musculature of the anterior tongue ventrum⁶. The non- encapsulated glands

of Blandin and Nuhn are a compact group of small mixed mucous and serous salivary glands, situated on both sides of the midline of ventral tongue surface, and are arranged in a mass with a horseshoe shape. They are embedded in the muscles of the ventral aspect, and re-covered by a thin layer of mucosa^{11,14}. Five to seven small ducts open in the oral cavity medial to the plica fimbriate on the undersurface of the tongue, near the lingual frenum. Each gland is about 8 mm in width and 12 to 25 mm in depth¹⁵. In this report the mucocoele was located in close proximity to these glands and therefore the source seems to be from a likely trauma to the glands of Blandin-Nuhn. Mucocoeles of the glands of Blandin-Nuhn can be located in the ventral tip of tongue or midway between the tip and the root of tongue and they can be situated in the midline or lateral to the midline¹¹.

The fluid from ruptured ducts or acini leaks and accumulates in the adjacent tissue.

Therefore, histopathological examination of mucocoeles of the glands of Blandin–Nuhn consist of mucus extravasation with no epithelium lining the mucin collection (figure 7)¹⁴. The resulting pool of glandular secretion gets surrounded by inflammatory cells (e.g. phagocytes and leukocytes) and reactive granulation tissue consisting of fibroblasts as a result of the immune response (Guimaraes, Hebling et al. 2006). The lymphocytes and macrophages tend to predominate over the polymorphs and additionally vascular engorgement is often evident, as seen in figure 6⁸. The development of granulation tissue is important to limit the spread of the mucus and to facilitate its removal by macrophages¹⁶. Even though there is no epithelium lining the cavity, sometimes the line of fibroblasts limiting the cavity can be confused with flattened epithelium cells^{13,14,17}.

Mucocoeles infrequently cause significant problems and in this instance neither

the patient nor her mother reported any symptoms or problems. However, discomfort, interference with speech, mastication, and swallowing, and external swelling can occur in some cases depending on their size and location⁸. Even though significant problems rarely arise, these lesions infrequently resolve sporadically and intervention is often recommended. The most common treatment of small mucocoeles involves surgical excision including the associated salivary gland and overlying mucosa, and this was the treatment chosen for this patient¹⁸. Other treatment options involve marsupialisation (creation of a pouch inside the mucocoele)⁸, cryosurgery (freezing)¹⁹ laser ablation¹⁸ and micro-marsupialisation¹⁰.

Mucocoeles, if not treated appropriately can often recur. In order to reduce the risk of recurrence it is important to remove any projecting peripheral salivary glands and also care should also be ensured to avoid injury to the other nearby glands and ducts⁸. In mucocoeles on the ventral surface of the tongue, often the glands are deep and commonly left behind, resulting in a higher risk of recurrence. Careful clinical evaluation of these lesions and good awareness of the gland anatomy can minimise the need for repeated surgical procedures¹⁴.

Based on the history of this lesion and the clinical presentation our provisional diagnosis was a mucocoele, however our initial differential diagnoses also included other lesions such as a lipoma and a traumatic fibroma. The tongue contains many tissues including adipose, connective tissue, blood vessels, nerves, and salivary glands, so pathosis of any of these tissues is possible. Palpation of the lesion in

addition to the clinical presentation may help in arriving at a differential diagnosis. This is because some lesions, for example lipomas and salivary gland tumours do not exhibit fluctuance. This is different to those lesions which have a fluid filled consistency such as cysts, mucocoeles, abscesses, and haematomas. As the clinical appearance of some lesions may be similar a needle aspiration might be performed in certain cases to rule out a vascular cause or a cystic mucoepidermoid tumour¹⁶. Sugerman and colleagues reported that a mucocoele on the ventral surface of the tongue may clinically resemble a vascular lesion, pyogenic granuloma, polyp, or squamous papilloma so all of these should be considered when formulating a provisional diagnosis and considering management options¹⁴.

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From “Point and Pull” to “Seal the Deal” – Transforming the way dental services are provided for disadvantaged children in Cambodia

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Abstract

In recent decades it has been common practice for dentists and dental students to spend time abroad providing dental services to disadvantaged communities in developing countries. While oral hygiene instruction may be given, the focus is usually on invasive treatments (especially extractions) rather than prevention. In contrast, the “SEAL Cambodia” project placed prevention at the core of its activities, and provided a vehicle for local and visiting dental personnel to deliver treatments that could have long term benefits. The goal of the SEAL Cambodia project was to provide GIC (Fuji VII) ‘fissure sealants’ on the first permanent molars of 60,000 Grade 1 and 2 children in Cambodia. The aim of this article is to report on the SEAL Cambodia project (that was partly supported by the ANZSPD), and also provide a rationale for the development of a new model called Healthy Kids Cambodia. Conclusions: Dental aid has been characterised in the past as ‘point and pull’, but now with the introduction of the SEAL Cambodia project, have been able to ‘seal the deal’, and open the door for a new approach called Healthy Kids Cambodia. This is a more holistic integrated model for addressing the dental caries burden in Cambodian children.

Introduction

Cambodian children have a severe burden of dental caries (dmft at age 6 = 9.0) and fewer than 1% of primary school children receive any restorative care¹.

In 2011 the Global Child Dental Fund (GCDF) initiated a meeting of local and international dental experts to consider a strategy for addressing the high rate of dental caries in Cambodian children. This resulted in the SEAL Cambodia project. The rationale was that by sealing the most susceptible permanent teeth (first permanent molars) soon after eruption, we could dramatically reduce the number of permanent teeth affected by dental caries. The aim of the present paper is to report on the SEAL Cambodia Project and introduce the Healthy Kids Cambodia Strategy.

A taskforce was created including the following members: the Cambodian Dental Association; the Dental Nurses School in Kampong Cham; the Faculty of Dentistry at International University; One-2-One Cambodia (which also functioned as the Beacon Centre of the GCDF in Cambodia); and Cambodia World Family (NGO). Later the Cambodia Buddhist Library Project (an NGO) and the University of Puthisastra became partners. The project received funding from CamKids (the Cambodian Children’s Charity), the GCDF, the ANZSPD, and GC Asia (which also provided the GIC for sealing the teeth). The Ministry of Health and Ministry of Education, Youth and Sport (MOEYS) provided administrative support. ANZSPD’s particular contribution included the provision of a tuk tuk for transporting the SEAL teams to the schools.

Initially a protocol and processes

were developed and field-tested. All participants in the project underwent training before being assigned schools to work in. Grade 1 and 2 children were targeted for sealing. In addition to the sealants, each child received a toothbrush and oral health education. The dental students and dental personnel from the partner organizations, along with many overseas volunteers, visited schools in Phnom Penh and three provinces over the subsequent three years of the project to apply sealants, according to well-defined criteria.

The coordinating NGO, One-2-One Cambodia, communicated with Ministry of Health, MOEYS and SEAL partners, purchased and stored the dental materials, printed the SEAL forms, provided supervision, training and monitoring, distributed dental instrument sets, held annual meetings with the partners, received and distributed funds from the donors, and entered the SEAL data into the computer. It also helped to coordinate the research aspects of the project, including obtaining approval from the National Ethical Committee for Health Research (Cambodia).

SEAL Cambodia – From ‘Point and Pull’ to ‘Seal the Deal’

By April 2016, 60,000 children had received GIC fissure protection (sealants) on their first permanent molars. However, the benefits of the project went far beyond this. As a result of SEAL Cambodia, the perceptions of children, dental students, visiting volunteers and



the wider Cambodian community have changed. In addition, the capacity of local organisations to mount such projects in schools has been enhanced.

Changing perceptions

Participating in the SEAL Cambodia project has changed the perceptions of local dental professionals, visiting dental volunteers, and the schools that participated. Local dental professionals began to understand what it meant to follow a strict, evidence-based protocol. They received feedback on the retention and caries preventive effect of the sealants that they placed and some were responsible for monitoring the quality of sealants placed by other providers. The sealants placed by Dental Nurses from One-2-One had a 10% higher retention rate compared to dental students from the three local dental schools². For the dental students who participated, SEAL Cambodia was often the first exposure they had to carrying out clinical work and not only did they get practical experience in moisture control, patient management and preventive care, the project also instilled in them the perception that GIC sealants and oral health education is a routine and central component of dental care provided for children³.

Visiting volunteers frequently participated in the SEAL Cambodia project and approximately one in ten children were treated by foreign volunteers⁴. One of the challenges of volunteering in a developing world context is to avoid doing work that could be accomplished by the local work force. Typically visiting dental students and dentists have favoured projects in which tooth extraction was the

main intervention. Just as local builders are capable of building schools, so too, local Cambodian dental students and professionals are capable of extracting teeth when this is required. And working through a school extracting hundreds of teeth is not likely to significantly improve children's oral health nor is it likely to promote favourable attitudes towards oral health and dentists. In fact it can leave the children and community in a state of shock.

Prior to SEAL Cambodia, it was very rare for local or visiting dental students and professionals to place fissure protection of any type, and there were no systems in place for the provision of preventive dental care (apart from daily tooth brushing) in the school environment. By participating in SEAL Cambodia, local personnel as well as visitors were helping to diversify the services, focus more on prevention, and actively support the development of new systems and networks for delivering care to young children in Cambodia.

The benefits of non-invasive care in a school environment were not lost on the children and school principals who both reported positive perceptions of the SEAL Cambodia project. Principals were happy with the SEAL project and a number wanted the services provided to be expanded to include other health interventions. The majority of children who were surveyed reported that they were happy to have sealants placed and spoke positively about the personnel who placed the sealants. They also understood that the reason for this intervention was "prevention of tooth decay".⁴

Building capacity

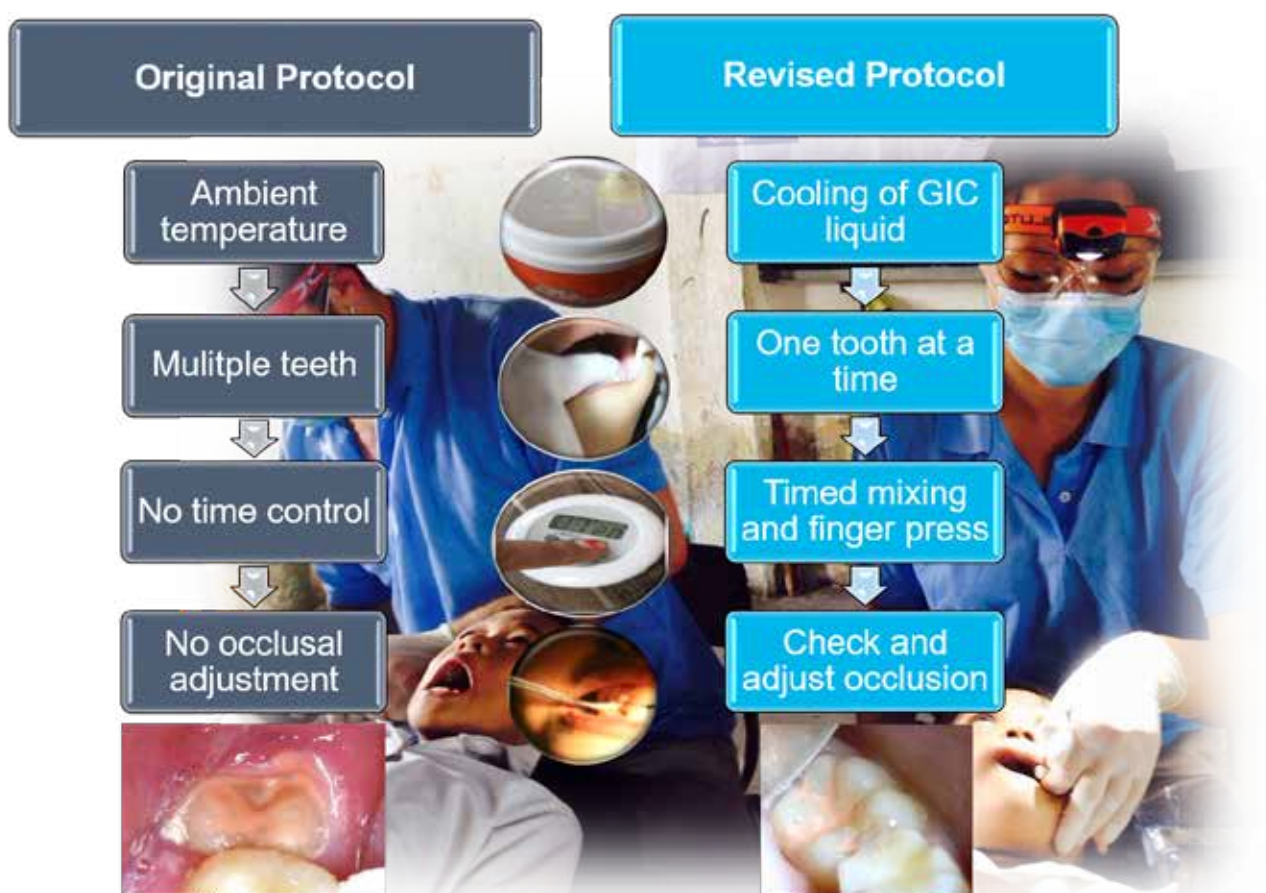
In addition to developing positive attitudes towards a more holistic and preventive approach to the problem of dental caries, we now had an infrastructure in place around SEAL to carry out training, provide dental services at low cost, distribute stores, establish relationships, and monitor and evaluate the effectiveness of the project. Though this project, key relationships were formed with the School Health Department and school principals. Nearly 200 schools participated, a number that would not have been possible without carefully fostering these relationships. This network is now the base upon which One-2-One and its partners can build and expand dental and other health services to children in Cambodia.

In addition to building organisational capacity, research capacity was also developed. A large number of dental students actively participated in small research projects to monitor caries progression and test parts of the protocol. The results of these projects were presented at local and regional conferences and so dental students not only built their capacity to conduct research but were also exposed to other countries and cultures and a wider array of research activities.

Prevention of dental caries

Those research projects, mostly carried out by dental students, informed the practice and protocols of the SEAL Cambodia project. What quickly became evident was that GIC fissure sealants did not render equal benefits for all patient groups. The children participating in the SEAL Cambodia project had an unprecedented burden of dental caries

Figure 1 – The Original and Revised protocols.



in contrast to other much lower-risk groups of children overseas who had received GIC sealants.⁵ We should not have expected the results to be the same. Under the original protocol for SEAL Cambodia, at 12 months, of those with extreme caries experience (dmft > 6), half of the participants did not get the expected reduction in caries increment on first permanent molars. The protocol (Figure 1) was therefore modified to add: (a) cool the GIC liquid prior to mixing; (b) time the mixing to manufacturers instructions; (c) only place one sealant at a time; and (d) adjust occlusion if needed. This modified protocol was then able to render a significant (90%) reduction in caries at 1-year, and the benefits were realised not just by “high-risk” children (dmft 3-6) but also for “extreme risk” children as well.⁶

From ‘SEAL Cambodia’ to ‘Healthy Kids Cambodia’

Is SEAL Cambodia the answer to the extreme dental caries problem in Cambodian children? It is certainly impressive that so many sealants could be consistently placed in very basic surroundings with very limited

instruments and materials at very low cost (US\$2.20 per child). The SEAL model is probably reproducible in other settings, as it has been shown to be easily implemented, acceptable, scalable, affordable and appears to provide significant benefits. The worst case scenario (under established protocols) for a child is that the sealant may “fall off”. If you are looking for a simple effective model of service delivery for preventing dental decay on first permanent molars then SEAL is a winner and can be confidently recommended to benefit school children in even very basic settings.

SEAL Cambodia is a great example of the ‘biomedical approach’ to preventing and managing dental caries. The biomedical approach has given the dental profession some useful tools such as fissure sealants and topical fluorides. We know that these treatments can be effective in preventing dental caries. However, although there is now greater availability of such preventive measures, the prevalence and severity of dental caries is increasing in Low and Middle income countries^{7,8} and in Cambodia, SEAL alone will not be the “silver bullet” we are looking for.

The SEAL model has delivered benefits for both those delivering services and for the 60,000 sealed children however, it has not addressed the underlying driver of dental caries. It has probably not significantly influenced the consumption of dietary sugars, the regular application of fluoride toothpaste, or other socio-behavioural factors associated with the development of dental caries. In addition, it has not addressed the existing carious lesions already present in the children when they arrive at school. And SEAL operates independently from any other health intervention.

For this reason, the authors have applied the conventions of the London Charter⁹ to develop the ‘Healthy Kids Cambodia’ strategy.

Healthy Kids Cambodia Healthy Kids Cambodia is a strategy built on a foundation of first establishing a healthy physical and social environment. The focus of the healthy physical environment is establishing appropriate group hand-washing and tooth-brushing facilities and limiting the sale of sugary foods and drinks on school premises (both of which are consistent with MOEYS policies).

Figure 2 – Levels in the Healthy Kids Cambodia Strategy

Healthy Physical Environment Healthy Social Environment	Level One	Health education Daily tooth brushing with a fluoride toothpaste Daily hand washing Bi-annual application of Silver Diamine Fluoride to arrest decay in primary teeth Deworming Vitamin A supplementation Basic health screening
	Level Two	GIC fissure sealants Atraumatic Restorative Technique (ART) Restorations
	Level Three	Conventional dentistry in a more controlled clinical setting eg Dental School, NGO clinic, Mobile dental service

Establishment of a healthy social environment involves setting up small working groups of stakeholders who can be involved in planning activities aimed at improving the health of the children, and who have access to referral networks. Once the school is working towards establishing a healthy environment then a sequential delivery of three service packages can be provided, depending on the resources and wishes of the school or community (Figure 2). Level 1 includes: daily hand-washing and tooth-brushing with fluoride toothpaste, and deworming (consistent with the Fit for Schools model)¹⁰; health education; health screening; and bi-annual application of Silver Diamine Fluoride to arrest caries in primary teeth. Level 2 includes the SEAL Cambodia protocols and also ART restorations. Both Level 1 and Level 2 are carried out in the school environment, in a school room or outside in a shaded area. Level 3 includes more conventional restorations and dental extractions, provided using mobile dental equipment in the school grounds, or in a fixed dental clinic. Level 1 activities can control most of the dental caries at very low cost, and can be carried out by dental or non-dental trained personnel.

The Healthy Kids Cambodia Strategy has been implemented on a small scale (around 3000 children) since February 2015, and initial indications are that approximately two in five children require Level 2 services, and one in five children require Level 3 services. SEAL Cambodia

is continuing within the framework of Healthy Kids Cambodia.

The more holistic approach of Healthy Kids Cambodia would not have been possible had SEAL Cambodia not developed the relationships, logistics and organisational capacity to implement a large scale preventive program at low cost. We are building on the agreements and close relationships with the School Health Department, schools and service providers. It is hoped that demonstrating the success of this new model will lead to policy changes and support for children to receive more integrated health care in Cambodia.

Conclusions:

SEAL Cambodia has been very effective at preventing dental caries in the first permanent molars of 60,000 children, building the capacity to deliver preventive services in the school environment, and establishing networks between Ministries, schools and providers. However, it does not go far enough. The new Healthy Kids Cambodia Strategy moves away from a simple biomedical approach to caries prevention, towards a more 'upstream' holistic approach at the school and community level.

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Sucrose. Does it have any analgesic effects on neonate and infant population?

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Introduction:

Sucrose is a naturally occurring disaccharide composed of fructose and glucose and is found in plants but is also commercially available as a common household sweetening agent. The soothing and pacifying properties of sugar in infants has been historically recounted and practiced across different generations and cultures. Recent research has focused on finding agents to alleviate pain in infants subjected to painful medical procedures in an attempt to minimise detrimental effect on neurobehavioral outcomes. A number of studies have been conducted to investigate the role and effects of sucrose as a potential non-pharmacological analgesic agent in the neonatal or infant population. Lingual frenotomy and removal of natal tooth are common procedures completed by paediatric dentists and the potential use of sucrose as an analgesic in these procedures may be of interest.

Most of the initial studies investigating the effect of sweet substances on pain responses were conducted on rodents. An association between sweetened food and endogenous opioid release has been showed in rodent studies, wherein intake of highly palatable food (ie chocolate) stimulated the release of beta endorphins in the hypothalamus¹. In another study, infusion of polycose and corn oil resulted in reduced pain response to thermal stimulus, however, the effect was transient with a rapid onset. Concomitant use of naltrexone has been shown to reduce the analgesic effect in the same study². An age dependent variation of sucrose's analgesic efficacy has been demonstrated in rat model. This was hypothesised to be related to the developmental changes in the endogenous analgesic mechanism and the complex interaction between the pain and gustatory pathway. It is believed that sucrose exerts its analgesic effect in human through the same mechanism as seen in the rodent model, however the degree of modulation may be different.

The World Health Organisation (WHO) supports the use of oral sucrose solution prior to single heel lance as a means to provide pain relief in infants, but at the same time acknowledges that the

long term effects of repeated dosing on the development of the infant is still unknown³. This recommendation is supported by the findings of a recent Cochrane review⁴ which demonstrated a reduction in different measures of newborn pain from procedures such as a heel lance, venipuncture and intramuscular injections. At this stage, there are no studies to examine the effect of sucrose on dental procedures.

The Children Hospital at Westmead and the Royal Children's Hospital (Melbourne) guideline^{5, 6} (Table 1) recommends that oral sucrose is a safe and effective mild analgesic for minor procedures and can be used in combination with alternative techniques such as non-nutritive sucking, kangaroo care, breastfeeding, positioning or swaddling. The combined use may further reduce the stress and pain experienced with certain procedures. The Australian Therapeutic Guidelines recommends the use of sucrose as a form of pain relief until the age of 4 months⁷. A Cochrane review in 2015 recommended that analgesic effects of sucrose may be indicated in infants up to approximately 12 months of age but there is evidence to suggest that the effectiveness is reduced as the infant gets older⁸. Similarly, the Royal Children's Hospital at Melbourne⁶ recommend that sucrose is most effective for preterm and termed neonates (less than 28 days old) but recognises that there are reports of some analgesic and calming effects up until 18 months of life⁹, this was hypothesized to be due to developmental changes in the endogenous pain and gustatory pathways.

A majority of the adverse effects reported in the literature has either have been self limiting, by not requiring any further medical intervention. Isolated reports of oxygen desaturation or bradycardia changes were noted after sucrose intake however these events also occurred in the controlled groups¹⁰ suggesting no causal relationship. The long term adverse effects especially with repeated dosing remains largely unknown and hence continued vigilance has been recommended. The current therapeutic guidelines⁷ do not recommend the use of sucrose in extremely low-birth weight (less

than 1000g) neonates or in infants with diagnosed sucrose intolerance (Sucrase-isomaltase deficiency), fructose intolerance or glucose-galactose malabsorption. The use of sucrose for the relief of pain is cautioned in preterm infants (< 32 weeks gestation), infants with suspected necrotising enterocolitis, unrepaired transoesophageal fistula, or altered gag or swallowing reflexes. Effectiveness of sucrose use is questionable in infants with mothers on methadone due to a potentially altered endogenous opiate system.

Due to the possible complex interplay between proposed pain pathways and the gustatory effect, sucrose solution is recommended to be taken orally. Two minutes prior to the procedure the sucrose solution can be applied either by placing a drop of the solution onto the infants tongue using a vial, syringe or pacifier¹¹. The peak effect appears to last about four minutes after administration however this is influenced by the infants' age and development. A systematic review¹² compared the efficacy of different sucrose doses (0.18g, 0.24g, 0.48g or 0.5g and 1g) with water. Five studies involving 271 infants were included for analysis¹². It was observed that doses of 0.24g were most effective in optimising behavioural and physiologic outcomes and a ceiling dose of 0.5g where no additional benefit was reported.

Conclusion

There is sufficient evidence to support the use of sucrose solution in minor non-dental procedures. However, further research involving larger sample sizes and better design is required to elucidate the true analgesic and calming effects of sucrose on dental related procedures. The dose of sucrose and its effect when used in combination with other behavioural and pharmacological treatment still requires clarification. In addition, the effect of repeated administration and the long-term effects is still largely unknown and hence continual surveillance is essential to ensure the safety and well being of the infant. This approach shows promise and may be something to consider when performing treatments in infants within the realm of paediatric dentistry

Table 1: Sucrose Oral Solution Dosing

	Strength of Solution	Dosing Regime
The Royal Children's Hospital (Melbourne)	33%	<ul style="list-style-type: none"> • >32 weeks to term, incremental doses 0.05 to 0.1mL up to 0.2 to 0.5mL maximum dose per single event • 0 to 1 month, incremental doses 0.05 to 0.1mL up to 0.2 to 1mL maximum dose per single event • 1 to 18 months, incremental doses 0.25 to 0.5mL up to 1 to 2mL maximum dose per single event
The Children's Hospital at Westmead	24%	<ul style="list-style-type: none"> • Neonate and infants up to 3 months of age: Dose per procedure 0.05-0.5mL, if required repeat the dose up to the total maximum prescribed dose of 10 drops (0.5mL). Maximum dose of 5 mL in 24 hours
Analgesic Therapeutic Guideline	25%	<ul style="list-style-type: none"> • 32-36 weeks gestational age: Max dose of 1mL *Nil specification on amount per dose • 37 weeks gestational age to 4 months of age: Max dose of 2mL of 25% solution *Nil specification on amount per dose
WHO	12-50%	<p>For Heel Lance procedure: 0.5 to 2mL</p> <p>* Nil specification on age dependent dosing</p>

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